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(54) Device for the continuous heat treatment of workpieces such as crankshafts, gears, rings and the like

(57) Apparatus for the continuous heat treatment of workpieces such as crankshafts, gears, rings and the like in a reversing pusher-type furnace comprising, in a closed furnace chamber, slideways for the intermittent feed of baskets between a loading station and a discharge station, the baskets being disposed in a row one against the other, and further comprising deviation devices for transferring individual baskets from one to the other slideway, is characterized by dispose a holding chamber aligned with the reversing pusher-type furnace 6 at the discharge end thereof, and with which there is associated a manipulator 7 by means of which the workpieces can be individually withdrawn and fed to a pressure-hardening machine 8 disposed in the direction of movement of the manipulator. The oil and water quenching tanks and a tilting table for discharge may be provided at the discharge end of the furnace.

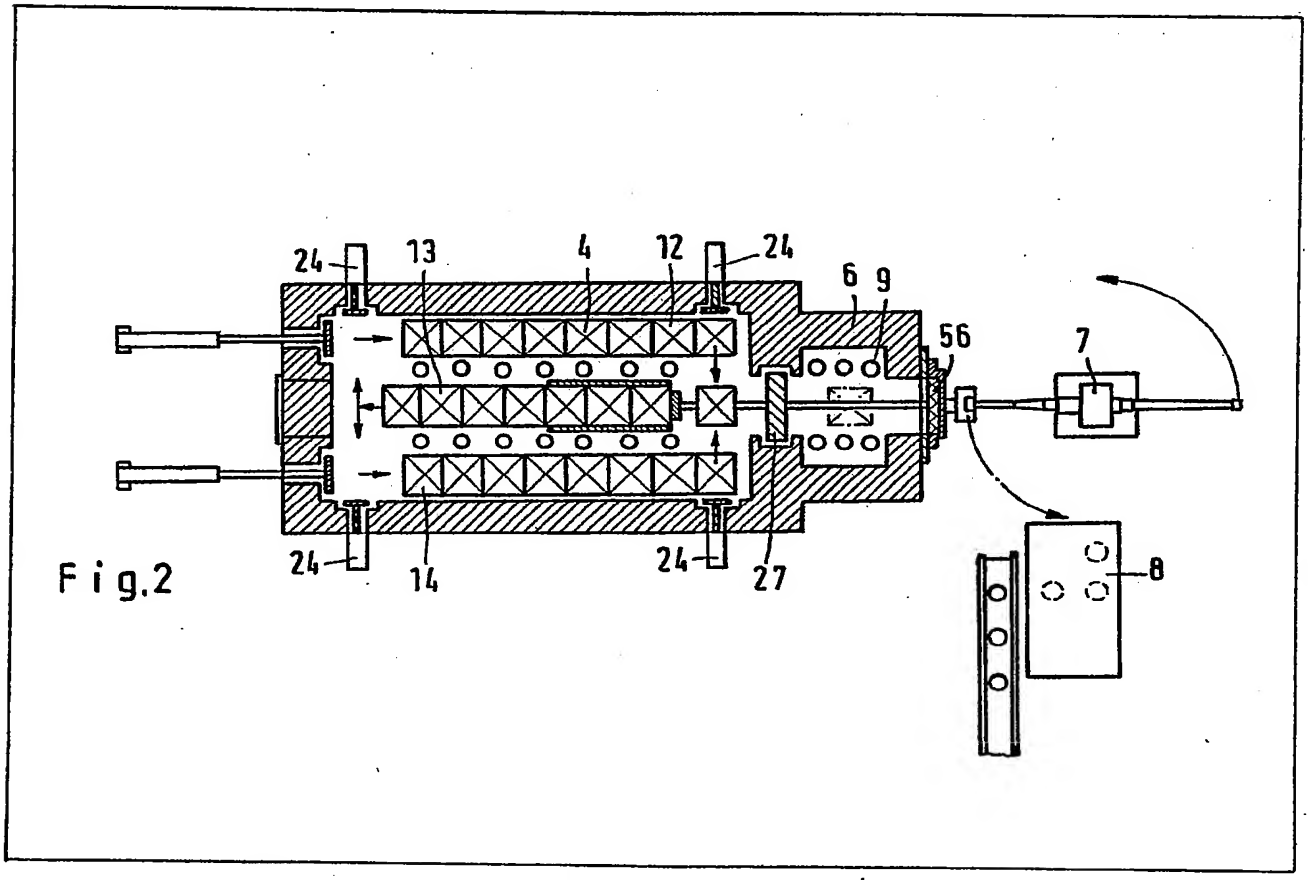

Fig.2

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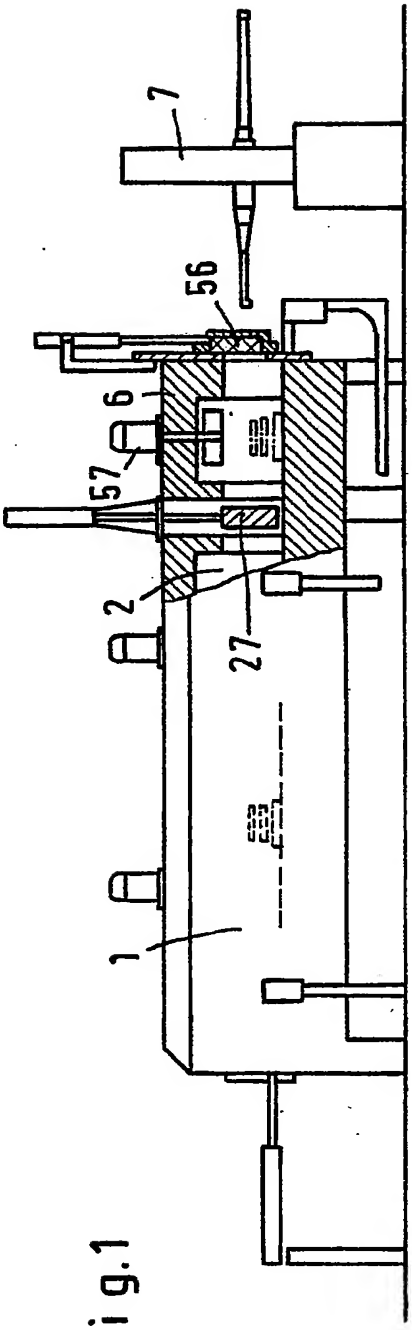

Fig.1

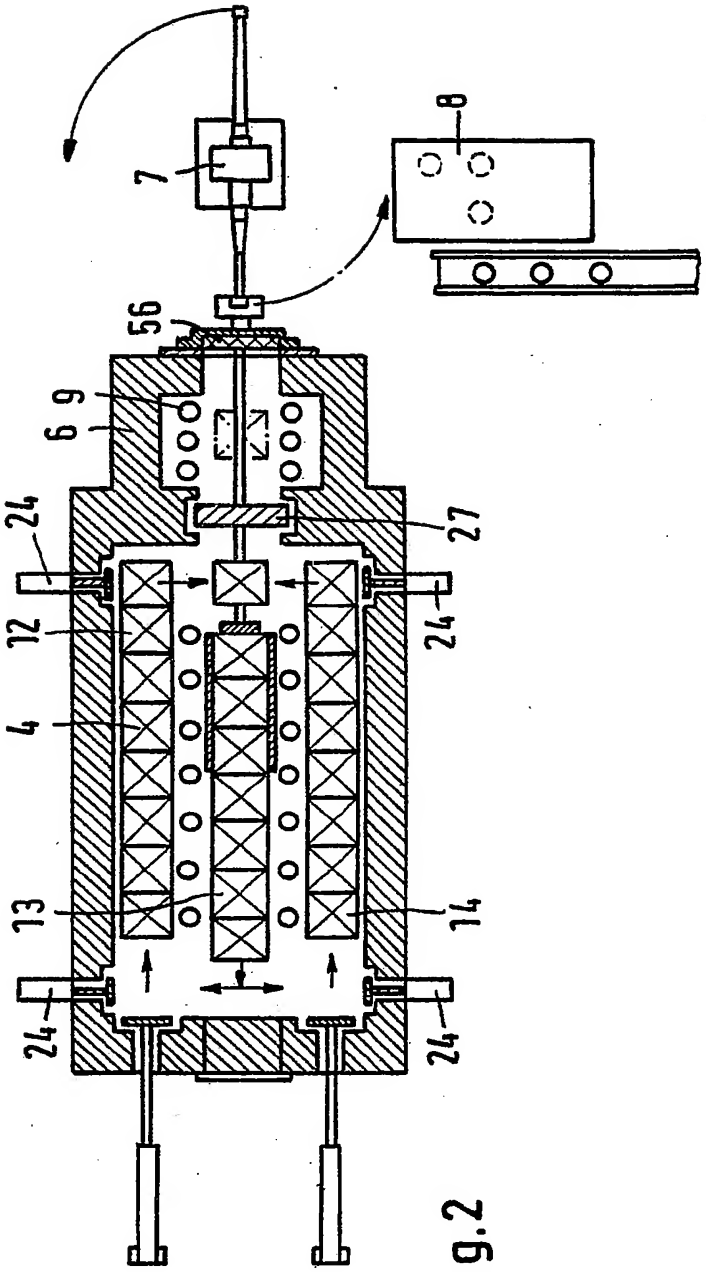

Fig.2

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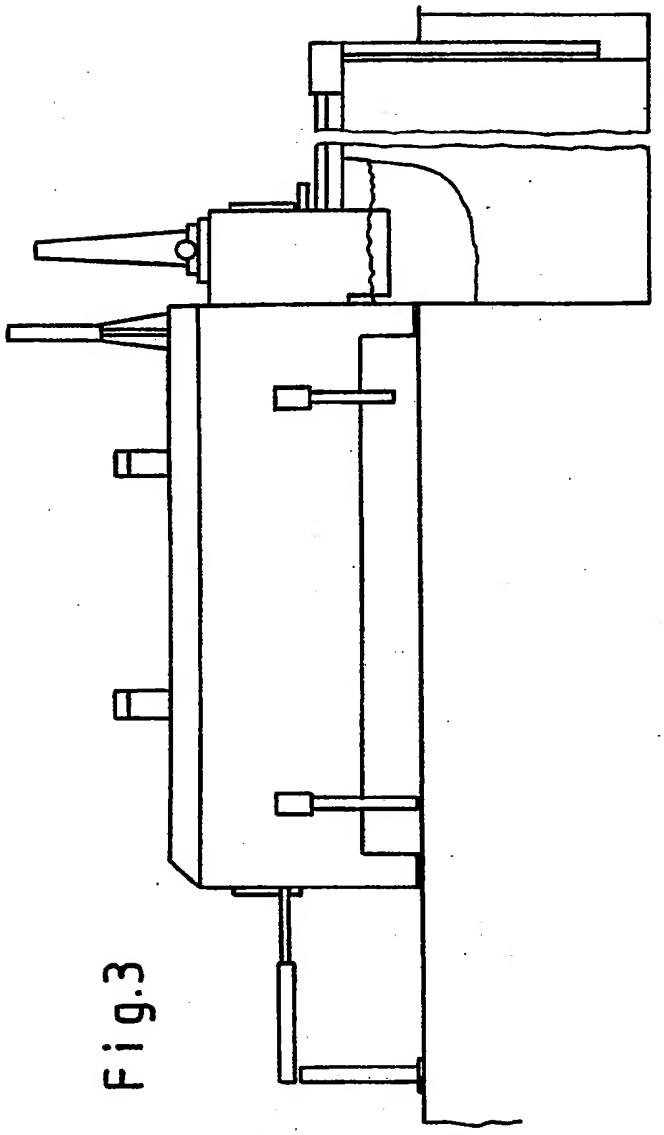


Fig.3

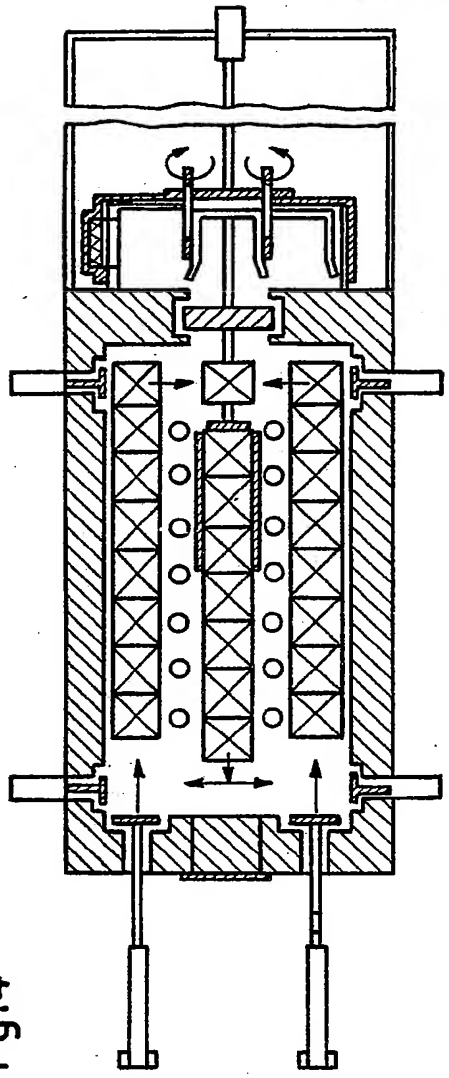
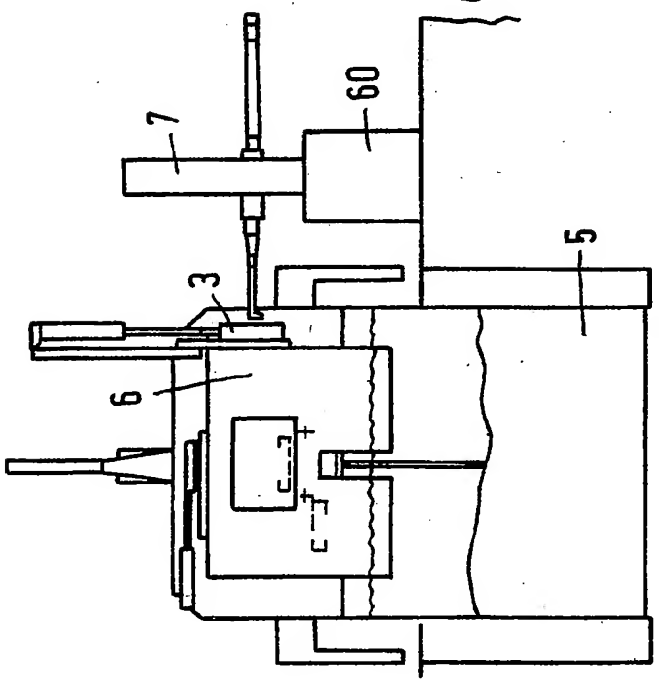
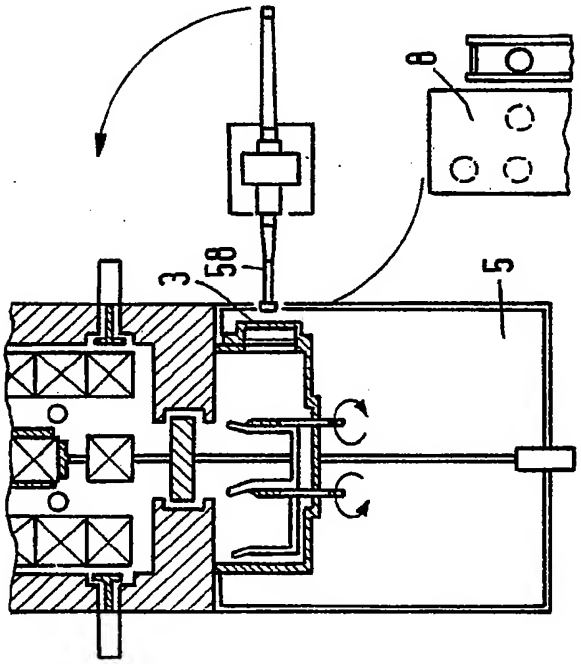


Fig.4





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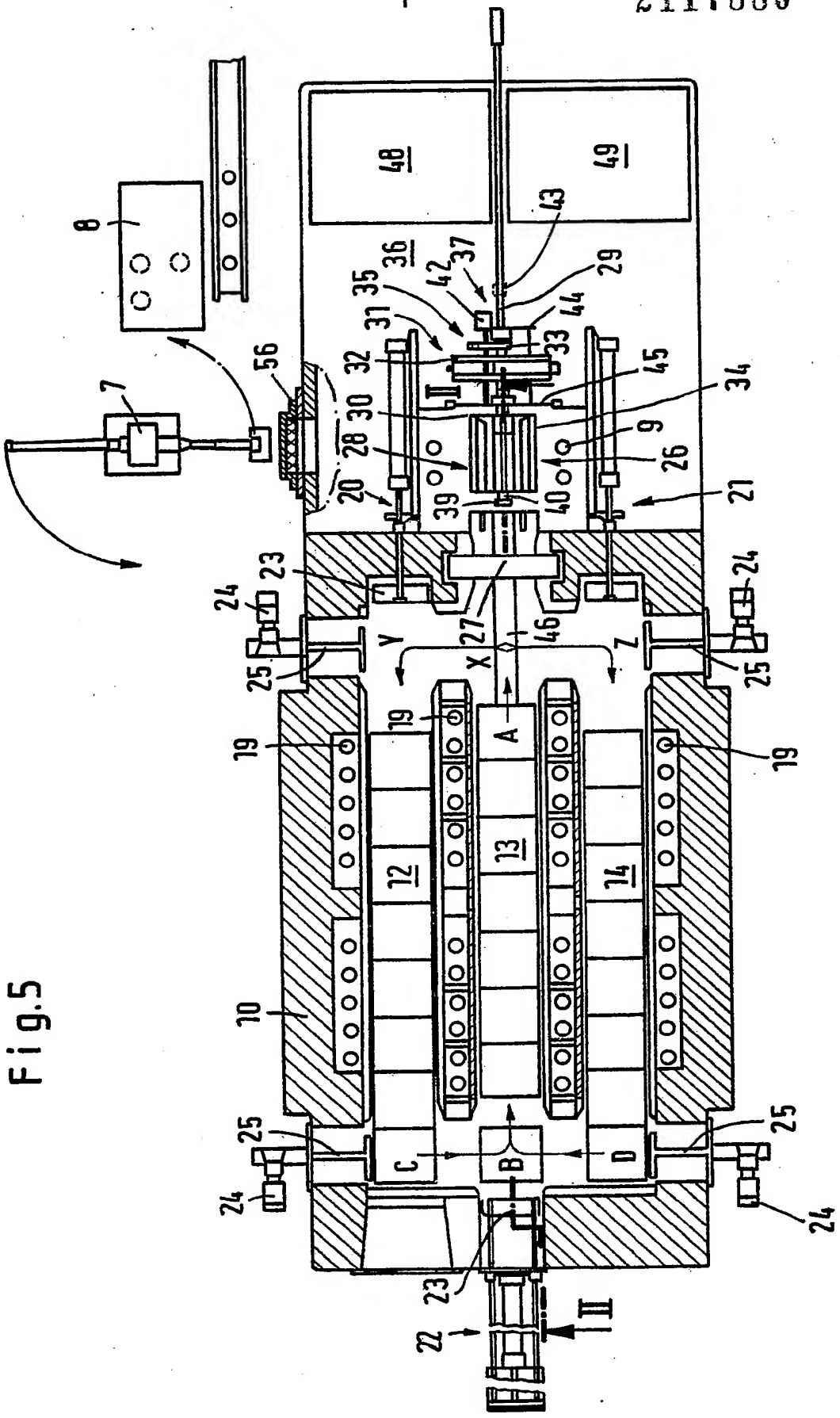

Fig.5

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Fig.7

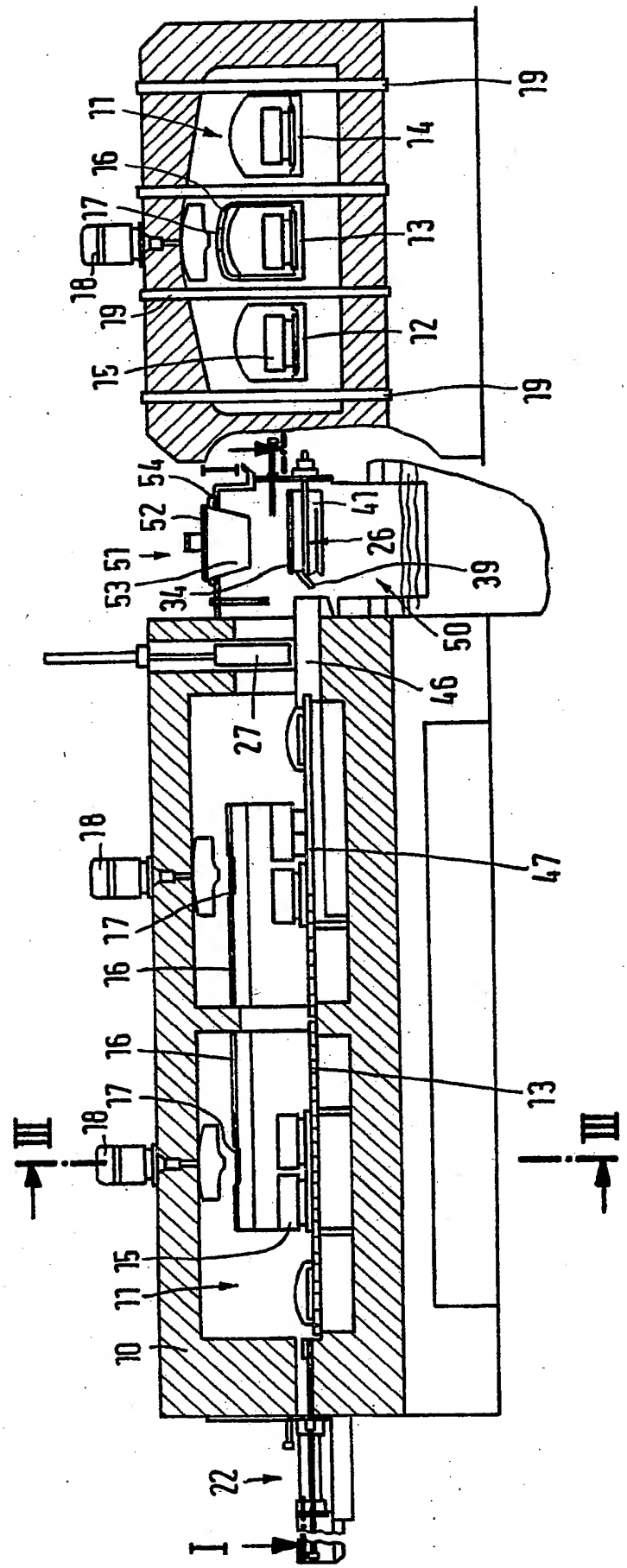

Fig.6

SPECIFICATION

Device for the continuous heat treatment of workpieces such as crankshafts, gears, rings and the like

The invention relates to a device for the continuous heat treatment of workpieces such as crankshafts, gears, rings and the like, in a reversing pusher-type furnace comprising, in a closed furnace chamber, slideways for the intermittent feed of baskets between a loading station and a discharge station, the baskets being disposed in a row one against the other, together with deviation devices for transferring individual baskets from one to the other slideway.

Such a reversing pusher-type furnace is known from DE-OS 2804338. In it, the loading station is formed at one end of the furnace, and the discharge station at the other end of the furnace. Two separately operating devices are therefore necessary for the loading and discharge operations. The hardening device pertaining to the oven is formed at the discharge end, and consists of two hardening baths and an overturning device by which the baskets taken from the middle slideway are overturned through 180° towards one or other side. The quenching tanks disposed thereunder are filled with two different media, e.g. water and oil. A drawback of this reversing pusher-type furnace is that only 2/3 of the technical furnace capacity is used because one slideway is reserved only for the return conveying of the empty baskets. In particular however, pieces such as crankshafts, gears, rings and the like cannot be subjected to heat treatment in this furnace because such workpieces require especially uniform cooling from all sides. For this purpose, hardening machines are used which grip the workpieces under high pressure, and individually dip them with these pressure devices into the hardening bath.

Workpieces to be pressure-hardened have up to the present time been heat treated in box furnaces or rotary hearth furnaces, because the workpieces can be taken from these either manually or by manipulators and fed into the hardening machine. A drawback is therefore the limited capacity of these furnaces, as only a few pieces can be prepared for pressure-hardening over a relatively long time.

The object of the invention is to provide an overall device by means of which continuous heat treatment of workpieces such as crankshafts, gears, rings and the like can be carried out in a heat treatment furnace of high throughput, from which the pieces can be individually removed and fed to a hardening machine for executing pressure-hardening. The aforesaid further drawbacks of the state of the art are also to be obviated. Among these is also to be considered the considerable drawback of gravity-discharge furnaces with basket feed, in which after leaving the furnace the baskets cool down, and must be heated up again for further feeding, leading to large heat and time losses.

The object is attained according to the invention in that a holding chamber is disposed aligned with the reversing pusher-type furnace of the initially described type at the discharge end thereof, and with which there is associated a manipulator by means of which the workpieces can be individually withdrawn and fed to a pressure-hardening machine disposed in the direction of movement of the manipulator. The basic idea of the invention is therefore the combination of a reversing pusher-type furnace with a holding chamber and a manipulator for individual handling, so that the crankshafts under continuous heat-treatment in the reversing pusher-type furnace can for example be held in the holding chamber at the holding temperature, which depends on the material, it can then be withdrawn by means of the manipulator, and fed along a path of movement to the pressure-hardening machine. Advantageously, the reversing pusher-type furnace comprises for this purpose three slideways disposed adjacently in a horizontal plane and provided on both sides in the region of the two ends with deviation devices, the middle slideway being connected by a conveying device to the holding chamber, which in combination with the manipulator is formed both as the loading and as the discharge station. In this manner, maximising of the technical furnace capacity is attained even with individual withdrawal, because not only can all three slideways be simultaneously brought into play for the heat treatment of the workpieces, but continuous loading and discharge of the reversing pusher-type furnace can also take place on a timed cycle basis.

The holding chamber preferably consists of a refractory-lined furnace chamber which can be heated by heating elements to a temperature of between 850°C and 900°C, and is connected by a common raisable and lowerable door to the reversing pusher-type furnace, and comprises a further door for loading and/or discharge, there being provided a forward and backward running pusher chain for conveying between the reversing pusher-type furnace and the holding chamber. The holding chamber can be provided with a fan for improved atmosphere circulation. Gas-heated radiation tubes are advantageously provided on both sides in a longitudinal direction in the holding chamber for heating purposes.

According to a desirable embodiment of the invention, the manipulator comprises a front and rear telescopic gripping arm and is disposed on a turntable so that it can rotate through 180° on both sides. It normally lies aligned coaxially with the reversing pusher-type furnace and the holding chamber, but as in the particular case of the embodiment described hereinafter can be disposed to the side of the holding chamber. By means of the telescopic gripping arms it is possible to extend and retract the manipulator in the holding chamber, so as to be able to effect the individual feed and withdrawal in a simple and space-saving manner.

For various applications of the combined device

according to the invention, it may be necessary not only to handle workpieces which are to be subjected to a pressure-hardening operation, but also small pieces such as screws. For this case, there is provided under the holding chamber a quenching bar which consists in particular of two containers which can be selectively filled with oil and water, and is fed from the holding chamber by way of an overturning device disposed therein and a dropping chute. The overturning device can be combined with an extraction device for the arriving baskets, which can be inserted into the furnace chamber and consists of a push-pull rod which can be slid to and fro in the longitudinal direction and comprises at its free end a hinged engagement member which can be swivelled in the direction of movement. The push-pull rod is rotatable with the overturning device. In this manner, it is possible to carry out the feeding and discharge of the holding chamber from the reversing pusher-type furnace, followed either by feeding the lowerly disposed quenching bath using the overturning movement, or by making an individual withdrawal and feeding the pressure-hardening machine using the manipulator.

Further details, characteristics and advantages of the subject matter of the invention will be apparent from the subsidiary claims and the description given hereinafter with reference to the accompanying drawing, which diagrammatically represents various embodiments of the invention, and in which:

Fig. 1. Is a side view of a reversing pusher-type furnace comprising a holding chamber and manipulator,

Fig. 2. Is a partly sectional and partly plan view of the device of figure 1,

Fig. 3. Shows two side views of a modified embodiment of a reversing pusher-type furnace comprising a holding chamber and manipulator,

Fig. 4. Shows two sections through the device of figure 3,

Fig. 5. Is a section on the line I—I through a reversing pusher-type furnace comprising a holding chamber and a supplementary quenching bath,

Fig. 6. Is a section on the line II—II of figure 5, and

Fig. 7. Is a section on the line III—III of figure 6.

The device shown in figure 1 of the drawing is for the continuous heat treatment of workpieces such as crankshafts. It consists of a reversing pusher-type furnace 1 comprising, disposed in a closed furnace chamber 2, slideways which as in the case of further embodiments described hereinafter are indicated by the reference numerals 12, 13, 14, and on which baskets 4 disposed in a row one against the other can be fed intermittently between a loading station and a discharge station. The loading station and discharge station is formed at the right end of the furnace in combination with a holding chamber 6 into which a manipulator 7 can grip. The conveying of the baskets 4 in the furnace chamber 2 from one slideway to another is carried out by means of deviation device 24, which are disposed on opposite sides of the reversing pusher-type furnace. An associated pressure-hardening machine 8 of known type and therefore not described in detail can be fed and discharged by means of a manipulator 7. The feed takes place directly from the holding chamber 6, in which the crankshafts are held in an atmosphere heated by means of heating elements 9 at a temperature of about 900°C, depending on the material, the atmosphere being circulated by means of a fan 57.

The device shown in figures 3 and 4 of the drawing differs from the aforesaid only in that the manipulator 7 is not aligned with the reversing pusher-type furnace and its holding chamber, but instead is disposed to the side thereof, so that a lateral door 3 driven by a lifting cylinder is provided for the feed and discharge of the holding chamber 6. This construction is necessary because in the reversing pusher-type furnace shown in figures 3 and 4, there is provided underneath the holding chamber 6 a quenching chamber 5 of the type described hereinafter comprising an oil bath and water bath, and which can be fed by means of an overturning device disposed in the holding chamber. This embodiment of the device according to the invention makes it possible both to treat individual parts such as crankshafts which have to be fed to the pressure-hardening machine 8, and to treat small parts which are hardened in the quenching bath.

The embodiment shown in figures 5, 6, and 7, representing the combination of a reversing pusher-type furnace with a holding chamber, quenching chamber, manipulator and pressure-hardening machine, not shown, is composed as follows. The reversing pusher-type furnace comprises a housing 10 consisting in the normal manner of refractory material, with an arch forming the furnace chamber 1, in which three slideways 12, 13, 14 of ceramic material are disposed adjacent to each other in the same plane. The slideways 12, 13, 14, which are connected together at their ends by suitably formed service pieces, are used for the intermittent feed of baskets 15 disposed in a row one against the other and filled with the material to be heat-treated, which can consist both of large pieces such as crankshafts which have to be pressure-hardened and of small pieces such as screws for hardening in the oil/water bath. The middle slideway 13 is preferably surrounded with a muffle 16 of refractory material to protect the charge against direct and too strong heating action. In the roof region of the muffle 16 there are provided openings 17 which together with the superposed fans 18 provide for uniform circulation of the furnace atmosphere. The furnace chamber 11 is heated with the aid of radiation tubes 19, through which the combustion and waste gases pass and which in this embodiment extend in the longitudinal directional preferably on both sides of each slideway 12, 13, 14.

The baskets 15 are fed with the aid of

pneumatically or hydraulically operated piston-cylinder units 20, 21, 22, which are disposed at the ends outside the housing 10 and are each aligned with one of the slideways 12, 13, 14. The free ends of the units are formed as pushers 23, and engage in the furnace chamber 11. In positions corresponding with the ends of the slideways and outside the longitudinal sides of the housing 11 there are provided pairs of opposing deviation devices 24, each consisting of a piston-cylinder unit. The free ends of the pistons of these units are likewise in the form of pushers 25, and engage laterally in the furnace chamber 11, in order to push the individual baskets from one slideway to the others in a manner described hereinafter.

At that end of the housing 10 distant from the piston-cylinder unit 22 there is provided, on the extension of the middle slideway 13, a discharge station 25 in the form of a holding chamber 6, which is connected in a gas-tight manner to the furnace chamber 11 and communicates with this latter by way of an inner door 27 which can be operated hydraulically or pneumatically. The discharge station 26 is provided with an overturning device 28, which consists substantially of a rotatably supported push-pull rod 29, a tipping frame 30 fixed on this latter, and a piston-cylinder unit 31 which acts as the drive unit and drives the push-pull rod 29 about its longitudinal axis by means of toothed racks 32 and a pinion 33. The tipping frame 30 is fitted with two parallel spaced-apart retention bars 34 which are so positioned that they co-operate with a corresponding undercut foot portion of the basket 15, and retain a basket inserted into the tipping frame 30 during its overturning movement through substantially 180°. When in its horizontal receiving position, the tipping frame 30 is locked by a locking device 35, of which the pin 36 engages in a suitably formed longitudinal groove in the push-pull rod 29.

The push-pull rod 29 also forms part of an extraction device, which comprises a further drive 37 for driving the push-pull rods 29 in the longitudinal direction, a guide carriage 41 and an engagement member 39 at the free end of the push-pull rod 29. The engagement member 39, which is substantially of forked formation at one end, fits rotatably on a shaft 40, which when the tipping frame 30 is in its rest position is horizontal and at a right angle to the central axis of the push-pull rods 29. The other end of the engagement member 39, with reference to the axis of rotation, points forward in a horizontal position and is heavier than the fork-shaped end, so that the engagement member 39 automatically tips from its horizontal position into a substantially vertical operating position by virtue of the weighted end.

In the region of its free end, the push-pull rod 29 is also provided with a guide carriage 41 which on the one hand serves for stabilising and guiding the forward and backward moving push-pull rod 29, and on the other hand serves as a stop for the weighted end of the engagement member 39 in its substantially vertical operating position.

The drive 37 provided for the push-pull rods 29 comprises a motor 42 driving a chain 43 which circulates endlessly below the push-pull rod, and engages with the push-pull rod 29 by way of an engagement member (see fig. 5).

The aforesaid extraction device and overturning device 28 are formed as a unit rotatable about the longitudinal axes. For this purpose, the two drive members 31 and 42 are fixed by means of a support 44 to an assembly plate 45 which rotates together with the push-pull rod 29.

The discharge station 26 is further connected to the interior of the housing 10 by way of a channel 46 which extends under the inner door 27 and under the level of the slideways 12, 13, 14, and through which that end of the push-pull rod 29 provided with the engagement member 39 and guide carriage 41 reaches at least to the position of the first basket 15 on the middle slideway 13. The height of the channel 46 is maintained such that during its forward movement, the engagement member 39 assumes the position shown in fig. 6, from which it tips into the vertical operating position at the moment it reaches the free space 47 below the first basket 15.

Below the discharge station 26 there is provided a quenching bath consisting of the two containers 48, 49 which are selectively filled with oil and water and into which the full baskets can be selectively emptied by way of a dropping chute 15.

The filling station 51 for small pieces is located above the discharge station 26, and is connected to the discharge station 26 by way of a horizontally slideable feed door 52 and a hopper-shaped feed chute 53. The chute opening of the feed chute 53 thus lies a certain distance above a basket 15 which has been inserted into the tipping frame 30.

The feed and withdrawal of individual pieces such as crankshafts is carried out by means of the manipulator 7 through the side door 3 of the holding chamber, by raising the door into its open position, inserting a telescopic gripper 58 of the manipulator 7 with the workpieces into the holding chamber through the door opening, and depositing the crankshaft in a basket present thereat. The withdrawal is carried out by rotating the manipulator 7 through 90° in the direction of the arrows of fig. 4 by means of the turntable 60, in order to feed the pressure-hardening machine 8.

With the aid of the other telescopic gripping arm 59 the loading and discharge operations of both the hardening machine and the holding chamber can be combined accordingly.

The reversing pusher-type furnace described with reference to figures 5—7 operates as follows (example relating to small pieces);

In the following operating procedure it will be assumed that all three slideways are covered with full baskets as shown in figure 1. When the cycle time expires, the extraction device together with

the engagement member 39 is inserted into the interior of the furnace until the end of the engagement member has arrived below the basket A. After opening the inner door 27, the basket A is drawn into an intermediate position in front of the tipping frame 30, and the inner door is again closed. The extraction device together with the engagement member then moves a further piece forwards until it is approximately below the inner door, it then engages with the end of the basket A and pulls it completely into the tipping frame until it operates a cylinder switch 54 fixed on the assembly plate 45. By virtue of the operation switch 54, the locking device 35 is made to release the locking of the overturning device. After the piston rod of the cylinder switch 54 has completely withdrawn, the piston-cylinder unit sets the push-pull rod 29 into motion and rotates the tipping frame 30 together with the basket A, of which the contents are emptied either into the water or oil bath depending upon the programme. The tipping frame is then again turned back into its horizontal initial position, and is fixed in this position.

The basket can be again loaded by opening the feed door 52 of the filling station 51. After filling has taken place, the feed door is again closed and the inner door 27 is opened. The extraction device now pushes the full basket A into position X with the aid of the push-pull rod 29 which for this purpose is provided with an appropriately formed thrusting surface 55. After closing the inner door, the basket A is pushed into position Y with the aid of one of the deviation devices 24. The deviation device is pulled back, followed by the extraction device, until it has again assumed the indicated position.

The piston-cylinder unit 22 now pushes the basket B onto the middle slideway 13 until a new basket has assumed position A. After this, the basket lying in position C is pushed into position B with the aid of the associated deviation device 24, after which the deviation device is immediately returned to its indicated initial position. By this means, space is provided for operating the piston-cylinder unit 20, which now further pushes basket A and thus all the baskets, until a basket again assumes position C.

As soon as the cycle time expires, the next basket is emptied and filled, but then takes the path indicated by the positions X—Z—D—B.

CLAIMS

1. A device for the continuous heat treatment of workpieces such as crankshafts, gears, rings and the like, in a reversing pusher-type furnace comprising, in a closed furnace chamber, slideways for the intermittent feed of baskets between a loading station and a discharge station, the baskets being disposed in a row one against the other, and further comprising deviation devices for transferring individual baskets from one to the other slideway, characterised in that a holding chamber (6) is disposed aligned with the reversing pusher-type furnace (1) at the discharge end thereof, and with which there is associated a manipulator (7) by means of which the workpieces can be individually withdrawn and fed to a pressure-hardening machine (8) disposed in the direction of movement of the manipulator (7).

2. A device as claimed in claim 1, characterised in that the reversing pusher-type furnace (1) comprises three slideways (12, 13, 14) disposed adjacently in a horizontal plane and provided on both sides in the region of the two ends with deviation devices (24), the middle slideway (13) being connected by a conveying device to the holding chamber (6), which in combination with the manipulator (7) is formed both as the loading and as the discharge station.

3. A device as claimed in claims 1 and 2, characterised in that the holding chamber (6) consists of a refractory-lined furnace chamber which can be heated by heating elements (9) to a temperature of between 850°C and 900°C, and is connected by a common raisable and lowerable door (27) to the reversing pusher-type furnace (1), and comprises a further door (56) for loading and/or discharge, there being provided a forward and backward running pusher chain for conveying between the reversing pusher-type furnace (1) and the holding chamber (6).

4. A device as claimed in 1 of claims 1 to 3, characterised in that the holding chamber (6) is provided with a fan (57) for atmosphere circulation.

5. A device as claimed in 1 of claims 1 to 4, characterised in that the holding chamber comprises gas-heated radiation tubes as the heating elements (9), these being distributed in the holding chamber on both sides in a longitudinal direction.

6. A device as claimed in 1 of claims 1 to 5, characterised in that the manipulator (7) comprises a front and rear telescopic gripping arm (58, 59) and is disposed on a turntable (60) to rotate through 180° on both sides.

7. A device as claimed in 1 of claims 1 to 6, characterised in that the manipulator (7) is aligned coaxially with the reversing pusher-type furnace (1) and the holding chamber (6), or to the side of this matter.

8. A device as claimed in 1 of claims 1 to 7, characterised in there there is provided under the holding chamber (6) a quenching bath which consists in particular of two containers (48, 49) which can be selectively filled with oil and water, and is fed from the holding chamber (6) by way of an overturning device (28) disposed therein and a dropping chute (50).

9. A device as claimed in claim 8, characterised in that the overturning device (28) is combined with an extraction device for the arriving baskets (15), which can be inserted into the furnace chamber (11) and consists of a push-pull rod (29) which can be slid to and fro in the longitudinal direction and comprises at its free end a hinged engagement member (39) which can be swivelled in the direction of movement.

10. A device as claimed in claim 9,

characterised in that the engagement member (39) can be tipped from the horizontal position into a vertical working position by means of the weight of a forwardly directed end.

11. A device as claimed in claims 9 and 10, characterised in that the push-pull rod (29) is provided in the region of its free end with a guide carriage (41).

12. A device as claimed in 1 of claims 9 to 11, characterised in that the push-pull rod (29) can be operated by means of a motor-driven chain (43) which engages with the push-pull rod (29) by way of a, in particular, rotatable engagement member.

13. A device as claimed in 1 of claims 9 to 12, characterised in that a piston-cylinder unit (31) is provided for operating the overturning device (28).

14. Apparatus for the continuous heat treatment of workpieces comprising a heat treating furnace, a holding chamber in communication with said furnace by means of an externally operable door, and means for removing workpieces from said holding chamber.

15. A device for continuous heat treatment of workpieces substantially as herein described with reference to any of the accompanying drawings.

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